New prediction model for cardiac arrest time of palliative care patients in the intensive care unit: a single center retrospective cohort study

S. Morishige, S. Takaki, S. Hayakawa, M. Yokose, O. Yamaguchi, T. Goto

Department of Anesthesiology and Critical Care Medicine, Yokohama City University School of Medicine

Background

- In the palliative care setting, family members of terminally ill patients wish to be present for the last moments of the patient's life. However, it is difficult to provide family members with an estimated time of patient's death with accuracy.
- We hypothesized that dysfunction of the autonomic nervous system resulting in an imbalance between systolic blood pressure (SBP) and shock index(SI: Heart rate/SBP) might precede cardiac arrest with a certain time interval.
- The aim of this study was to develop the algorithm to predict cardiac arrest in terminally ill patients.

Methods

- We retrospectively collected data of patients admitted to the intensive care unit (ICU) at Yokohama City University Hospital between 2010 and 2016 and diagnosed with cardiac arrest on the ICU.
- Exponential decay model was used to develop the formula to calculate the predicted SI from SBP.
- The disparity between predicted HR, which was calculated from predicted SI, and real HR was evaluated as the predictor of cardiac arrest in the following 120 minutes .
- Patient data were randomly divided into the development set and the validation set. The development set was used to determine the threshold of the HR disparity with the receiver operating characteristic curve(ROC), and the validation set was used to validate the formula by determining the diagnostic power of the threshold.

Figure. 1 Process of enrollment and allocation to the development set or validation set.

80% of all data sets were allocated to the development set (9,621 of 12,026). The residual 20 % of data sets were allocated to the validation set. (2,405 of 12,026)

Results

- Of 4330 patients who were admitted to the ICU, 32 died in the ICU and 19 patients were included in this study.(Fig.1)
- Exponential decay model determined the following formula:
$$\text{Predicted HR} = \text{SBP}(0.995 + 5.936e^{-0.035 \times \text{SBP}})$$
 (Fig.2)
- Median and interquartile range of the disparity in the two data sets are 1.90 (-9.8 to 14.5) for the volatile data set and -9.8 (-23.5 to 4.5) for the terminal data set, respectively. Area under the ROC of the disparity between real HR and predicted HR was 0.650 (95% confidence interval 0.512 to 0.788), $p < 0.001$. (Fig.3)
- Threshold of the disparity was -10 bpm (sensitivity, 49.9%; specificity, 75.8%; likelihood ratio, 2.06). In the validation data set, diagnostic power of this algorithm was sensitivity 52.7 % (47.8 to 57.6), specificity 79.8 % (78.0 to 81.6), positive predictive value 35.7 % (31.9 to 39.6), and negative predictive value 88.8 % (87.2 to 90.3). Likelihood ratio 2.61, respectively.

Figure. 2 Plot of the association between shock index and systolic blood pressure in the volatile set and terminal set

Figure. 3 ROC curve of disparity between heart rates (real heart rate – predicted heart rate) between volatile set vs. terminal set.

Volatile set: 1.90 (-9.8 to 14.5) Terminal set: -9.8 (-23.5 to 4.5)
 $p < 0.001$
Area under the ROC curve: Area: 0.650 (0.512 to 0.788), $p < 0.001$

Conclusion

In patients requiring palliative care, the new prediction model estimates the breakdown of the autonomic nervous system within 2 hours of cardiac arrest.

Conflicts of Interest and Source of Funding: